2004P04056

B6

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
10 January 2002 (10.01.2002)

PCT

(10) International Publication Number
WO 02/03581 A2

(51) International Patent Classification[7]: H04G

(21) International Application Number: PCT/EP01/07624

(22) International Filing Date: 3 July 2001 (03.07.2001)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
0016420.2 5 July 2000 (05.07.2000) GB

(71) Applicant *(for all designated States except US)*: **MOTOROLA INC** [US/US]; 1303 East Algonquin Road, Schaumburg, IL 60196 (US).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: **AITKENHEAD, Gary** [GB/GB]; 34 Strawberry Fields, Bramley, Hampshire RG26 25QF (GB). **URS, Kamala, Diane** [US/US]; 861 Tallgrass Drive, Bartlett, IL 60103 (US).

(74) Agent: **MCCORMACK, Derek**; Motorola European Intellectual, Property Operations, Midpoint, Alencon Link, Basingstoke, Hampshire RG21 7PL (GB).

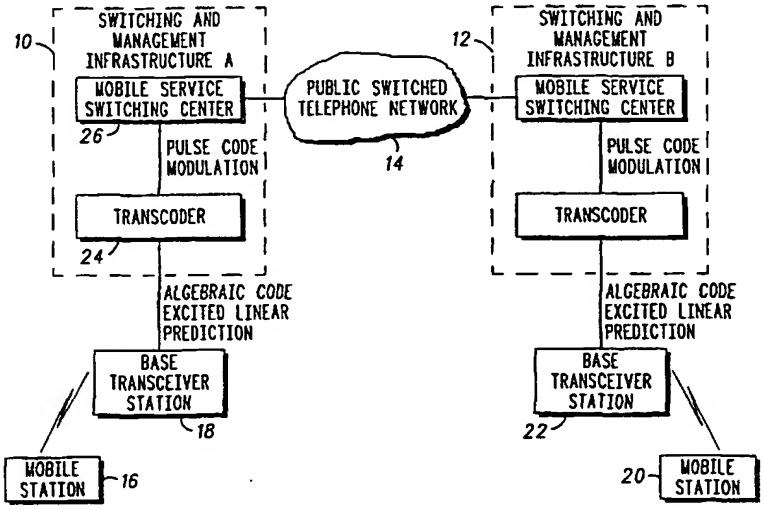
(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published:
— *without international search report and to be republished upon receipt of that report*

[Continued on next page]

(54) Title: RADIO COMMUNICATIONS SYSTEM, BASE TRANSMITTER STATION AND METHOD FOR SUPPORTING HALF DUPLEX CALLS



(57) Abstract: A method of communication for supporting half-duplex communications via a full-duplex link, the method comprising the steps of: sending a communication in half duplex format from a first mobile radio communications station MS (38) to a first base transceiver station BTS (40); converting the format of the communication in half duplex format received at the first BTS into a full duplex format and sending the communication converted into the full duplex format from said first BTS (40) to a second BTS (44); converting the format of the communication received at the second BTS back into a half duplex format at the second BTS and sending the communication in the half duplex format to a second MS (42); thereby delivering the communication from said first MS (38) to said second MS (42).

WO 02/03581 A2

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

RADIO COMMUNICATIONS SYSTEM, BASE TRANSMITTER STATION AND METHOD FOR SUPPORTING HALF DUPLEX CALLS

Field Of The Invention

The present invention relates to a radio communications system, base transmitter and method for supporting half duplex calls.

Background Of The Invention

In a half duplex communications system between two portable or mobile radio communications units or the like, herein referred to collectively as mobile stations, MSs, a message is allowed to be sent by only one MS at a time. Thus, such systems need to include a signalling procedure or protocol to establish which MS is to be allowed to transmit. After a connection has been established by such a procedure a communication message, e.g. representing speech of a user, is sent by the MS which has been authorised to transmit. There is also a signalling procedure to indicate that a transmitted message has come to an end. Permission to transmit is commonly requested by a 'push to talk' mechanism. Permission to transmit is flipped back and forth as necessary between the two MSs to enable a two way conversation to take place. This form of communication is also referred to in the art as 'dispatch calling'. MSs including those which operate according to a half duplex procedure may operate according to the Terrestrial Trunked Radio (TETRA) system which is a modern digital sytem using standard industry procedures. The signals representing speech in such a system are in a digital ACELP (algebraic code excited linear prediction) format.

In contrast, a full duplex system is one in which when a connection has been

established between two transceivers either transceiver may transmit at any time. Public Switched Telephone Networks (PSTNs) generally provide full duplex communications. The signals representing speech in these systems is generally in a different format from that of half duplex systems, e.g. it is in a PCM (pulse code modulation) format.

Many cellular telephone systems provide national or international roaming to their subscribers via inter-system connections to similar systems in other regions or countries, typically via full duplex PSTNs. An example of such an arrangement is shown in Figure 1 of the accompanying drawings. In the arrangement of Figure 1, two network switching controllers known as Switching and Management Infrastructures (SwMIs) 10 and 12 each have a transcoder (XCDR) 24 and a mobile service switching centre (MSC) 26. The two SWMIs are interconnected via a PSTN 14, with a Mobile Station (MS) 16 in communication with a Base Transmission Station (BTS) 18 that is under the control of SwMI 10, and a MS 20 in communication with a BTS 22 that is under the control of SwMI 12. Unfortunately, such arrangements typically support only a subset of services for inter-system communications. For example, inter-system duplex telephone calling is supported, while half-duplex calling is not. This is because PSTNs do not currently provide control signalling necessary to support half-duplex calling. This could prove to be a serious limitation where an important call is initiated in a half duplex format and the call fails because it cannot reach its destination in that format.

Summary Of The Invention

The present invention provides a novel system, method and apparatus for use therein for enabling half duplex, e.g. Push-To-Talk (PTT), messages to be sent via a full duplex link such as a Public Switched Telephone Network (PSTN). Such a system, method and apparatus is not available in the prior art.

In accordance with the present invention in a first aspect there is provided a method of communication for supporting half-duplex communications via a full-duplex link, the method comprising the steps of :

sending a communication in half duplex format from a first mobile radio communications station MS to a first base transceiver station BTS;

converting the format of the communication in half duplex format received at the first BTS into a full duplex format and sending the communication converted into the full duplex format from said first BTS to a second BTS;

converting the format of the communication received at the second BTS back into a half duplex format at the second BTS and sending the communication in the half duplex format to a second MS;

thereby delivering the communication from said first MS to said second MS.

In the method according to the first aspect of the invention, the full duplex communication may be sent via a communication link comprising a public switched telephone network, PSTN . The full duplex link may itself comprise a plurality of links of different types, e.g. landline, radio and optionally other links. The communication sent by the first BTS may be introduced into the PSTN and extracted from the PSTN by the second BTS via network switching controllers which conventionally are used to provide introduction and extraction of communications by MSs into and out of such a network.

'Mobile station (MS)' as used herein is intended to include portable and mobile radio telephones and radio transceivers. 'Base transceiver station (BTS)' as used herein is intended to refer to a fixed transceiver which is operable to send radio communications to and receive radio communications from a mobile station (MS).

In the method according to the first aspect of the invention, the conversion of

communication formats of signals representing speech carried out by the BTSs may be between a half duplex format which comprises a non-PCM format, such as a coded speech digital signal format, and a full duplex format which comprises a pulse code modulation (PCM) signal format. The non-PCM signal format may comprise a Terrestrial Trunked Radio (TETRA) digital signal format.

The method according to the invention may further comprise the step of establishing connection along the full duplex link enabling the communication to take place by a procedure wherein the first BTS produces a call set up signal identifying the second MS, the call set up signal being in a format which is recognised by the full duplex system, e.g. especially a DTMF (dual tone multi-frequency) format which is recognised by many PSTNs. Such a call set up signal may be sent via a speech channel of the full duplex link. In such a procedure, the second BTS may be operable to convert such a set up signal back into an identity signal recognised by the second MS as a half duplex call set up signal.

The present invention beneficially provides a signalling and communications method that can be deployed to include a transcoder bypass operation. A transcoder is a known device needed for example to convert between the format, e.g. PCM, required for transmission via a full duplex link such as a PSTN and another format, such as a non-PCM format, used outside such a link. However, use of a such a transcoder adds to the cost and complexity of a communications system. For transmissions that originate from a MS that uses a non-PCM coded format which are destined for a MS that uses the same non-PCM coded format, it is clearly beneficial to avoid transcoding. The method, system and apparatus according to the invention may be operated in a manner such that if a transcoder is included to provide communication in the full duplex link, the transcoder may be by-passed by the provision by the first BTS of a transcoder by-pass signal when a half duplex

signal is detected by the first BTS as described herein.

In the method according to the first aspect of the invention, there may be included the step of establishing transmit permission at a maximum of one of said MSs at any given time. One of said MSs may thus be a calling MS and the other of said MSs a called MS, the method further comprising the step of establishing, prior to sending said communication, a default transmit permission condition wherein one of said MSs has transmit permission. The step of maintaining the half duplex transmit permission of either of said MSs may be made at either of said BTSs.

The method according to the first aspect of the invention may further include the steps of:

handing off one of said MSs to a third BTS; and

transmitting, from the BTS from which said MS is being handed to said third BTS, the half duplex transmit status of said MS being handed off. Alternatively, the method may include the steps of:

handing off one of said MSs to a third BTS; and

transmitting, from the BTS from which said MS is not being handed off to said third BTS, the half duplex transmission status of said MS being handed off.

The method according to the first aspect of the invention may further include the step of transmitting a half duplex transmission control signalling message from a sending one of said BTSs to a receiving one of said BTSs using in-band signalling via the full duplex connection between the two BTSs. The transmitting step may be made via a transcoder bypass. The transmitting step may be made by transmitting said half duplex transmission control signalling message via an unused bit of at least one octet of a transcoder bypass transmission. The transmitting step may comprise:

defining a message header in bits 5-8 allocated to an ACELP packet, wherein said message header denotes that subsequent bits include an in-band signalling message; and

transmitting said half duplex transmission control signalling message via any of said subsequent bits.

In the method according to the first aspect of the invention, the sending of the communication in half duplex format between the second BTS and the second MS may comprise said first BTS inserting an end-to-end signalling message into a setup message indicating a half-duplex call request. Iinitiating the half-duplex communication between the second BTS and the second MS may be brought about by a network switch controller associated with said second BTS identifying a half duplex call request from a telephone number associated with either of said MS.

The method according to the first aspect of the invention may further comprise the step of transmitting a "half duplex reject" message from one of said BTSs to the other of said BTSs. The BTS receiving such a message may request half duplex transmission permission if the other rejecting BTS currently maintains the permission to transmit for an MS currently connected to said rejecting BTS. Alternatively, a "half duplex on acknowledgement" message may be sent from one of said BTSs to the other one of said BTSs where neither of said MSs currently has permission to transmit and both of said BTSs simultaneously send a "half duplex on" request to each other.

According to the present invention in a second aspect, there is provided a communications system comprising:

a first MS adapted to communicate with a first BTS in a half duplex format;

a first BTS adapted to convert the format of a half duplex format

communication from the first MS into a full duplex format and to send the communication in full duplex frmat to a second BTS;

a second BTS adapted to convert the format of the communication received in full duplex format from the first BTS into half duplex format and to send the communication in half duplex format to a second MS via a full-duplex connection and via a full-duplex transmission medium; and

a second MS adapted to receive the communication in half duplex format from the second BTS;

wherein said first MS is allowed to transmit a communication in half duplex format to be received in half duplex format by said second MS. The system may be operable to carry out the method according to the first aspect.

According to the present invention in a third aspect there is provided a base transmitter station operable to perform the conversion of communications between half duplex and full duplex format for use in the method according to the first aspect. The base trasmitter station may be operable to serve as either the first BTS or the second BTS as defined herein, or both.

Therefore, transmission of half duplex messages and control signalling for such transmissions is beneficially enabled via a full duplex link such as a PSTN by the present invention. This is achieved by suitable conversion at the first BTS of the format of such a call made by the first MS to enable transmission along the full duplex link to take place and re-conversion at the second BTS of the call into a format recognised by the second MS.

In particular, the present invention beneficially provides a signalling and communications method, system and apparatus that can beneficially include a transcoder bypass operation.

The present invention may be applied to inter-system connections and migration to foreign systems, and, indeed, to any situation where full-duplex links are to be used as the bearer of calls made in a half-duplex format where no signalling mechanism for half-duplex transmission is provided by the full duplex link or network.

Thus the present invention provides a method and system of communication between two remote MSs via a link which has not previously been available. This unexpectedly and beneficially provides a solution to the problem of prior art systems described earlier in which calls initiated in half duplex format are unable to reach their destination if this has to be reached via a full duplex link.

US 5,297,147 describes an in-band signalling technique that allows transcoding to be bypassed. However, it is not contemplated in this reference to send half duplex communications via a full duplex network as described herein.

GB 2,321,160A describes a system wherein a MS can provide single slot or multi-slot data transmissions over an air interface. Again, it is not contemplated in this reference to send half duplex communications via a full duplex network as described herein.

Embodiments of the present invention will now be described by way of example with reference to the accompanying drawings, in which:

Brief Description Of The Drawings

Figure 1 is a simplified illustration of a prior art radio communications inter-system arrangement;

Figure 2 is a simplified tabular illustration of a prior art PSTN audio information coding scheme;

Figure 3 is a simplified tabular illustration of a prior art traffic format for indicating that transcoder bypass should occur;

Figure 4 is a simplified illustration of a system for PTT transmission control via a PSTN, constructed and operable in accordance with a preferred embodiment of the present invention;

Figure 5 is preferred method for converting a half-duplex call into a full-duplex call, operable in accordance with a preferred embodiment of the present invention;

Figure 6 is a simplified control flow illustration of PTT signalling operative in accordance with a preferred embodiment of the present invention;

Figures 7 and 8, taken together, are simplified illustrations of messaging structures for transcoder bypass in-band PTT signalling, operative in accordance with a preferred embodiment of the present invention;

Figure 9 is a simplified control flow illustration of BTS handoff with PTT signalling, operative in accordance with a preferred embodiment of the present invention; and

Figure 10 is a simplified control flow illustration of BTS handoff with PTT signalling, operative in accordance with another preferred embodiment of the present invention.

Detailed Description Of Embodiments of the Invention

Reference is now made to Figure 4 which is a simplified illustration of a system for PTT transmission control via a PSTN, constructed and operable in accordance with a preferred embodiment of the present invention. As in the system of Fig. 1, the system of Fig. 4 shows two Switching and Management Infrastructures (SwMIs) 28 and 30, each having a transcoder (XCDR) 32 and a mobile service switching centre (MSC) 34, interconnected via a full-duplex transmission link,such as a PSTN 36. A PTT-capable Mobile Station (MS) 38 is in communication with a Base Transmission Station (BTS) 40

that is under the control of the SwMI 28, and a PTT-capable MS 42 is in communication with a BTS 44 that is under the control of the SwMI 30. A suitable platform for the BTSs 40 and 44 is an Enhanced Base Transceiver System (EBTS), manufactured by Motorola Inc., and described in Motorola Equipment Manual 68P81091E20, suitably modified as needed to implement methods described hereinbelow with reference to Figs. 4 to 10. Such modification is well within the ordinary capability of persons familiar with the construction and operation of BTSs.

An exemplary operational scenario of the system of Fig. 4 is now described with additional reference to Fig. 5, which is a preferred method for converting a half-duplex call into a full-duplex call, operable in accordance with a preferred embodiment of the present invention, and Fig. 6, which is a simplified control flow illustration of PTT signalling operable in accordance with a preferred embodiment of the present invention. In Figs. 5 and 6, MS 38 and BTS 40 are referred to as "MS A" and "BTS A" respectively, and MS 42 and BTS 44 are referred to as "MS B" and "BTS B" respectively. A control time line is represented in Fig. 5 by an arrow 46.

Fig. 5 shows a simplified signalling sequence used by a BTS to set up a full-duplex call on behalf of MS A making a half-duplex call to MS B in another system. BTS A handles the call as half-duplex via a half-duplex connection between MS A and BTS A, while it uses full-duplex call set-up signalling via the MSC to establish a full-duplex connection via the PSTN. On the receiving side BTS B handles the call as half-duplex via a half-duplex connection between MS B and BTS B. Once the full-duplex connection is in place, BTS A and BTS B can use a PTT transcoder bypass in-band signalling mechanism described herein to handle PTT transmission control.

The sequence of steps shown in Fig. 5 is as follows. MS A requests that a half-

duplex call to MS B in another system be set up, and sets up a half-duplex connection to BTS A. BTS A recognises that the half-duplex call type cannot be carried via the PSTN via SwMI A to SwMI B. Therefore, BTS A converts this call into a full-duplex call 52 using as full-duplex connection the link via the MSC of SwMIA and the PSTN 36 to the MSC of SwMI B 30 associated with BTS B. A signal representing the identity of MS B may be transmitted by BTS A to reach BTS B. The signal may be in DTMF format. BTS B detects that the call it receives is a half duplex call, such as through end-to-end signalling inserted by BTS A into a set up message to SwMI B or by the type of number used for the calling or called party, as the numbering scheme used for full duplex telephone calls is normally different from that used for half duplex private calls. In any event, a signal representing the identity of MS B may be transmitted by BTS A to reach BTS B. The signal may be in DTMF format. BTS B, on detecting that the incoming call request is for a half-duplex call, sets up a half-duplex connection to MS B. The call set-up proceeds with an alerting phase followed by a connect message when MS B answers the call, which results in BTS A being through-connected to BTS B with a full-duplex path. However, BTS A and BTS B continue to signal the call as a half-duplex call to MS A and MS B respectively.

Once the call is through-connected, in-band signalling may be used to control the transmission permission, as now seen more particularly in Figure 6. The control flow illustration of Figure 6 begins with neither MS A nor MS B currently having permission to effect a PTT transmission. MS A then sends a request to initiate a half duplex PTT transmission to BTS A. BTS A is preferably aware of the current PTT transmission status. By knowing the current PTT transmission status, the BTS at which the call originates ensures that only one MS at a time has permission to transmit. BTS A then sends a "PTT

on" request to BTS B via PSTN 36 and SwMI 30. In response, BTS B sends a "PTT on" acknowledgement to BTS A. BTS A then notifies MS A that it has permission to transmit. BTS B also preferably notifies MS B that PTT transmit permission has been granted to MS A. When MS A ceases transmission, MS A indicates this state to BTS A which, knowing that MS A currently has PTT transmit permission, sends a "PTT off" request to BTS B via PSTN 36 and SwMI 30. In response, BTS B sends a "PTT off" acknowledgement to BTS A. BTS A then notifies MS A that it no longer has permission to transmit. BTS B also preferably notifies MS B that MS A's PTT transmit permission has been revoked.

There are at least two situations where collision control may be required to ensure that only one MS at any particular time has permission to transmit. Firstly, where BTS A makes a transmission request on behalf of MS A, yet MS B currently has permission to transmit, and such permission status is maintained at BTS B, BTS B may respond with a "PTT reject" message instead of a "PTT on" acknowledgement, thereby rejecting the transmission request. Secondly, there is a risk in the case where neither MS has permission to transmit and both BTSs simultaneously send a "PTT On" request to each other. In this case the collision may be resolved in several ways. For example, the call originator could be deemed to have the highest priority so that the BTS associated with the call originator responds to the "PTT On" request with "PTT reject," while the other BTS responds with a "PTT On Acknowledgement". In this way, only one BTS holds the transmit permission. Alternatively, the BTS that last held the transmit permission could be deemed to be lower in priority so that the transmit permission priority is alternated between the BTSs in the call.

All PTT transmission control signalling between BTS A and BTS B is preferably performed using transcoder bypass in-band signalling whereby PTT signalling is

included in the in-band signalling when transcoder bypass is enabled. To effect this, the existing transcoder bypass mechanism is preferably enhanced to allow unused bit slots to contain PTT messages in the same manner as the synchronization sequence, described earlier with reference to Figure 3.

Reference is now made to Figures 7 and 8 which, taken together, are simplified illustrations of messaging structures for transcoder bypass in-band PTT signalling, operable in accordance with a preferred embodiment of the present invention. Reference to octets in Figure 7 is hereinafter used to denote "logical" octets constructed from the concatenation of bit streams carried by the unused bit number 1 of multiples of the "physical" octet shown in Figure 3. Using this bit stream, various PTT signalling messages, such as are defined in Figure 8, may be sent. Normally, bit number 1 is set to zero when no PTT signalling information is being transmitted. Therefore, a signalling message is preferably preceded with a two-octet synchronisation sequence 78 to allow the receiving end to detect that a signalling message is to follow. As an alternative to using bit '1' for the signalling stream, bits 5-8 allocated to ACELP packets could be used to define a message header that could be used to denote that the following information is either an ACELP formatted packet or an in-band signalling message. The signalling message itself preferably contains:

- a length indicator 80 which specifies how many octets there are in the PTT message;
- a header 82 which indicates the PTT message type;
- an optional information field 84 which may be present according to the message type and contain parameters relevant to that message; and
- a checksum 86 which is used to ensure that no errors occurred in the message during transmission.

Typically, the "PTT On 88," "PTT Off 90," and "PTT State Request 92" messages shown in Fig. 8, do not have any information field. The "PTT State Response 94" message preferably has a one-octet information field indicating one of three values:

- PTT On;
- PTT Off; and
- No PTT.

This information field indicates whether MS A currently has PTT transmit permission, whether MS B currently has PTT permission, or whether neither MS A nor MS B has permission.

Reference is now made to Figure 9, which is a simplified control flow illustration of BTS handoff with PTT signalling, operable in accordance with a preferred embodiment of the present invention. If either MS A or MS B requires a handoff from one BTS to another, a new serving BTS, to which the MS's current PTT permission status is unknown, must be informed of the MS's current PTT permission status so that the PTT transmission control mechanism can be preserved. This may be achieved as part of the normal handover signalling using conventional techniques as shown in Figure 9. MS A issues a handover request 102 to the current serving BTS, labelled "BTS A (old) 96," which forwards the request 104 to its MSC 100 along with the current PTT transmit status of MS A. The MSC 100 then transmits the handover request and PTT status 106 to the new serving BTS, labelled "BTS A (new) 98" which acknowledges the request 108 and receives the current PTT transmit status. The MSC 100 then issues the handover command to BTS A (old) 110 which notifies MS A of the handover 112. Such handover signalling is a typical known procedure used for example in iDEN systems where GSM-type cellular signalling is extended such that some information is passed transparently via the MSC

from the old BTS to the new BTS. This end-to-end user information field may therefore be used to carry the PTT transmit state between the old and new BTS in accordance with this embodiment of the present invention.

Reference is now made to Figure 10, which is a simplified control flow illustration of BTS handoff with PTT signalling, operable in accordance with a preferred embodiment of the present invention. The method illustrated in Figure 10 is an alternative to the method shown in Figure 9. In Figure 10 BTS A (new) 122 uses in-band signalling, such as the XCDR-bypass PTT control mechanism described earlier, via a wired or wireless connection to BTS B 120 after handover has been completed to retrieve the transmit state from BTS B.

CLAIMS

1. A method of communication for supporting half-duplex communications via a full-duplex link, the method comprising the steps of :

sending a communication in half duplex format from a first mobile radio communications station MS (38) to a first base transceiver station BTS (40);

converting the format of the communication in half duplex format received at the first BTS into a full duplex format and sending the communication converted into the full duplex format from said first BTS (40) to a second BTS (44);

converting the format of the communication received at the second BTS back into a half duplex format at the second BTS and sending the communication in the half duplex format to a second MS (42);

thereby delivering the communication from said first MS (38) to said second MS (42).

2. A method according to claim 1 wherein said full duplex communication is sent via a communication link comprising a public switched telephone network, PSTN .

3. A method according to claim 2 and wherein the communication sent by the first BTS is introduced into and extracted from the PSTN via network switching controllers.

4. A method according to any one of the preceding claims and wherein the format of communications is converted by the BTSs between a half duplex format which comprises a non-pulse code modulated format and a full duplex format which comprises a pulse code modulated signal format.

5. A method according to claim 4 and wherein the non-pulse code modulated format comprises a Terrestrial Trunked Radio (TETRA) digital signal format.

6. A method according to any one of the preceding claims and which further comprises

the step of establishing connection along the full duplex link enabling the communication to take place by a procedure wherein the first BTS produces a call set up signal identifying the second MS, the call set up signal being in a format which is recognised by the full duplex system.

7. A method according to claim 6 and wherein the format of the call set up signal produced by the first BTS is dual tone multi-frequency format.

8. A method according to claim 7 and wherein the call set up signal is sent via a speech channel of the full duplex link.

9. A method according to claim 6, claim 7 or claim 8 and wherein the second BTS is operable to convert the call set up signal back into an identity signal recognised by the second MS as a half duplex call set up signal.

10. A method according to any one of the preceding claims and further comprising the step of establishing transmit permission at a maximum of one of said MSs (38,42) at any given time.

11. A method according to any one of the preceding claims wherein one of said MSs (38,42) is a calling MS, wherein the other of said MSs (38,42) is a called MS, the method further comprising the step of establishing, prior to sending said communication, a default push to talk, PTT, transmit permission condition wherein either of said calling MS and said called MS has PTT transmit permission.

12. A method according to claim 11 and further comprising the step of maintaining the PTT transmit status of either of said MSs (38,42) at either of said BTSs (40,44).

13. A method according to claim 12 and further comprising the steps of:

handing off one of said MSs (38,42) to a third BTS; and

transmitting, from the BTS (40,44) from which said MS is being handed to

said third BTS, the PTT transmission status of said MS (38,42) being handed off.

14. A method according to claim 12 and further comprising the steps of:

handing off one of said MSs (38,42) to a third BTS; and

transmitting, from the BTS (40,44) from which said MS is not being handed off to said third BTS, the PTT transmission status of said MS (38,42) being handed off.

15. A method according to any of the preceding claims the method further comprising the step of:

transmitting a half duplex transmission control signalling message from a sending one of said BTSs (40,44) to a receiving one of said BTSs (40,44) using in-band signalling via the full-duplex connection between the two BTSs.

16. A method according to claim 15 and wherein said transmitting step comprises transmitting said half duplex transmission control signalling message via an in-band transcoder bypass transmission.

17. A method according to claim 16 and wherein said transmitting step comprises transmitting said half duplex transmission control signalling message via an unused bit of at least one octet of said transcoder bypass transmission.

18. A method according to claim 16 or 17 and wherein the transmitting step comprises:

defining a message header in bits 5-8 allocated to an ACELP packet, wherein said message header denotes that subsequent bits include an in-band signalling message; and

transmitting said half duplex transmission control signalling message via any of said subsequent bits.

19. A method according to any one of the preceding claims and wherein sending the communication in half duplex format between the second BTS and the second MS

comprises said first BTS (40) inserting an end-to-end signalling message into a setup message indicating a half-duplex call request.

20. A method according to any one of the preceding claims wherein said initiating said second half-duplex connection step comprises a network switch controller (30) associated with said second BTS (44) identifying a half-duplex call request from a telephone number associated with either of said MSs (38,42).

21. A method according to any of the preceding claims the method further comprising the step of transmitting a "half duplex reject" message from one of said BTSs (40,44) to the other of said BTSs (40,44) requesting half duplex transmission permission if said rejecting BTS (40,44) currently maintains the permission to transmit for one of said MSs (38,42) currently connected to said rejecting BTS (40,44).

22. A method according to any one of the preceding claims the method further comprising the step of transmitting a "half duplex reject" message from a call originating one of said BTSs (40,44) to a call receiving one of said BTSs (40,44) and transmitting a "half duplex on acknowledgement" message from said call receiving one of said BTSs (40,44) to said call originating one of said BTSs (40,44) where neither of said MSs (38,42) currently has permission to transmit and both of said BTSs (40,44) simultaneously send a "half duplex on" request to each other.

23. A communication system comprising:

a first MS (38) adapted to communicate with a first BTS (40) in a half duplex format;

a first BTS adapted to convert the format of a half duplex format communication from the first MS into a full duplex format and to send the communication in full duplex frmat to a second BTS (44):

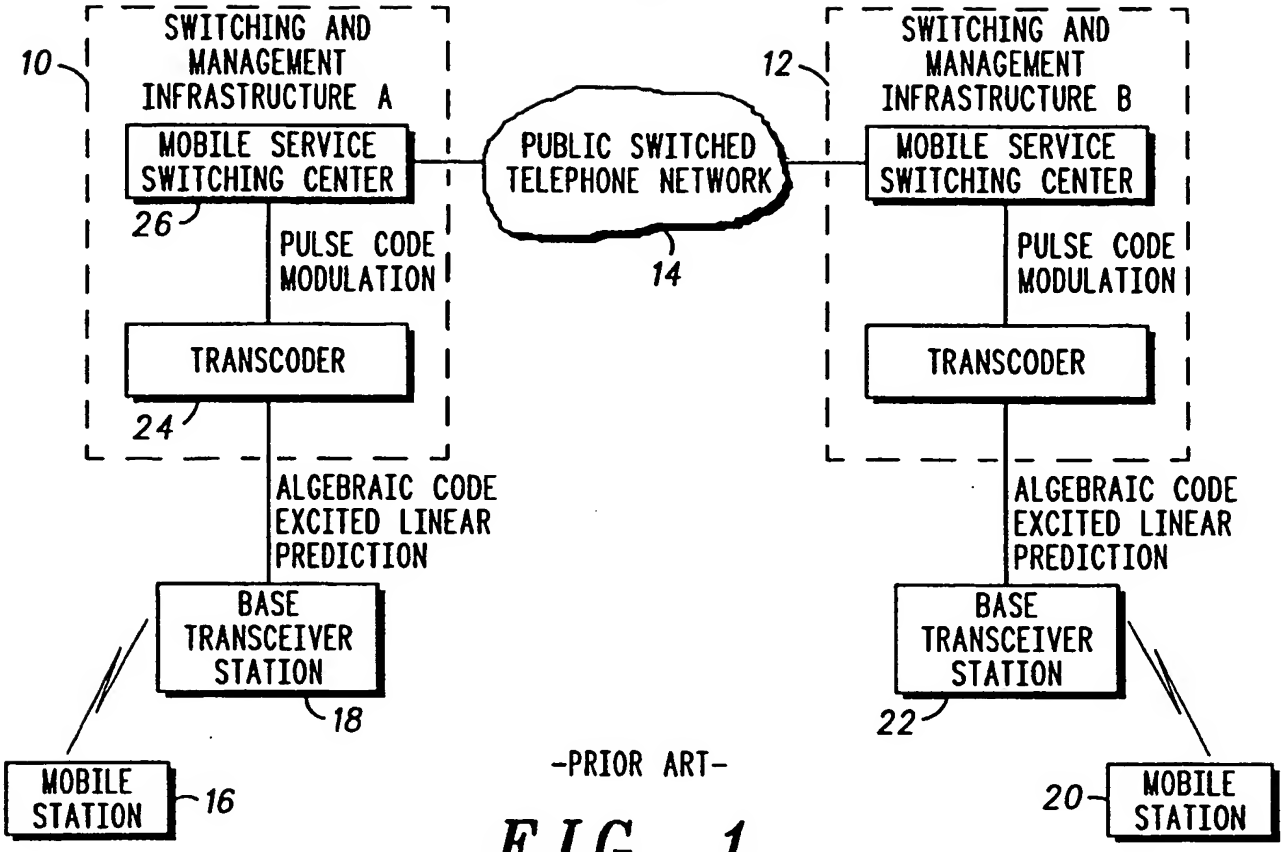
a second BTS (44) adapted to convert the format of the communication received in full duplex format from the first BTS (40) into half duplex format and to send the communication in half duplex format to a second MS via a full-duplex connection and via a full-duplex transmission medium (36); and

a second MS (42) adapted to receive the communication in half duplex format from the second BTS.

wherein said first MS (38) is allowed to transmit a communication in half duplex format to be received in half duplex format by said second MS.

24. A communications system according to claim 23 and which is operable according to the method claimed in any one of claims 1 to 22.

23. A base transmitter station operable to perform the conversion of communications between half duplex and full duplex format for use in the method claimed in any one of claims 1 to 22.



-PRIOR ART-

FIG. 1

BIT NUMBER							
8	7	6	5	4	3	2	1
PCM SAMPLES AT 64KB/S							

-PRIOR ART-

FIG. 2

BIT NUMBER							
8	7	6	5	4	3	2	1
ACELP PACKETS AT 64KB/S				FRAME	BYPASS	SYNC	UNUSED

-PRIOR ART-

FIG. 3

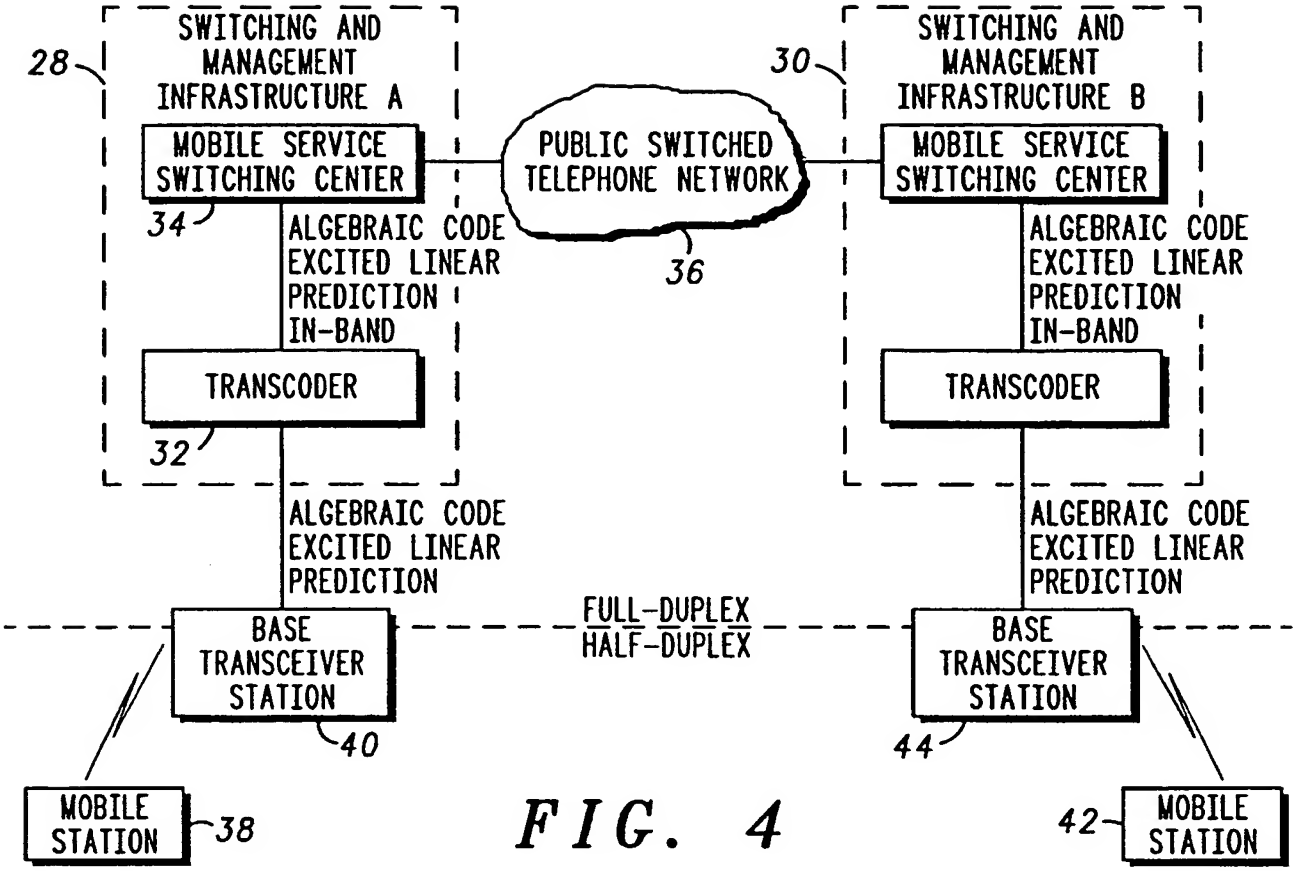

SWITCHING AND MANAGEMENT INFRASTRUCTURE A
28
MOBILE SERVICE SWITCHING CENTER
34
ALGEBRAIC CODE EXCITED LINEAR PREDICTION IN-BAND
TRANSCODER
32
ALGEBRAIC CODE EXCITED LINEAR PREDICTION
BASE TRANSCEIVER STATION
40
MOBILE STATION
38
PUBLIC SWITCHED TELEPHONE NETWORK
36
FULL-DUPLEX
HALF-DUPLEX
SWITCHING AND MANAGEMENT INFRASTRUCTURE B
30
MOBILE SERVICE SWITCHING CENTER
ALGEBRAIC CODE EXCITED LINEAR PREDICTION IN-BAND
TRANSCODER
ALGEBRAIC CODE EXCITED LINEAR PREDICTION
BASE TRANSCEIVER STATION
44
MOBILE STATION
42

FIG. 4

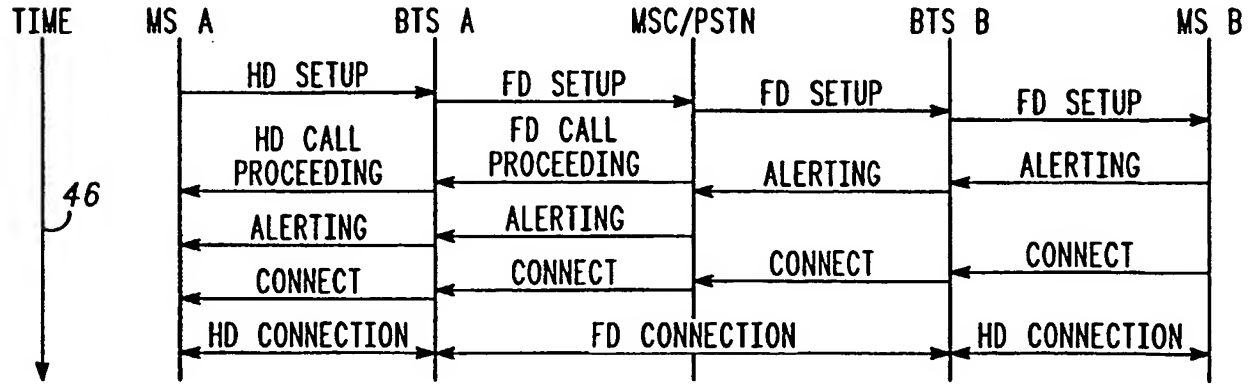

TIME
MS A
BTS A
MSC/PSTN
BTS B
MS B
46
HD SETUP
FD SETUP
FD SETUP
FD SETUP
HD CALL PROCEEDING
FD CALL PROCEEDING
ALERTING
ALERTING
ALERTING
ALERTING
CONNECT
CONNECT
CONNECT
CONNECT
HD CONNECTION
FD CONNECTION
HD CONNECTION

FIG. 5

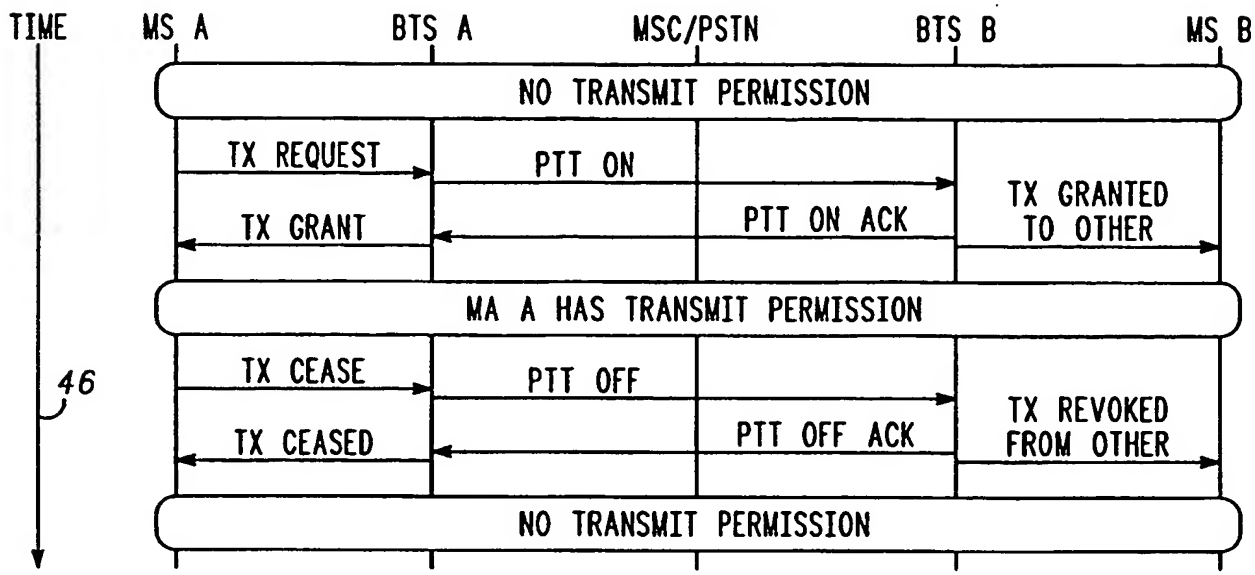


FIG. 6

BIT NUMBER 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1	No. OF OCTETS	
SYNCHRONIZATION SEQUENCE	2	78
LENGTH OF MESSAGE	1	80
HEADER	1	82
INFORMATION	N	84
CHECKSUM	2	86

FIG. 7

HEADER VALUE	MESSAGE	
00000000	PTT ON	88
00000001	PTT ON ACK	
00000010	PTT OFF	90
00000011	PTT OFF ACK	
00000100	PTT STATE REQUEST	92
00000101	PTT STATE RESPONSE	94
00000110	PTT REJECT	

FIG. 8

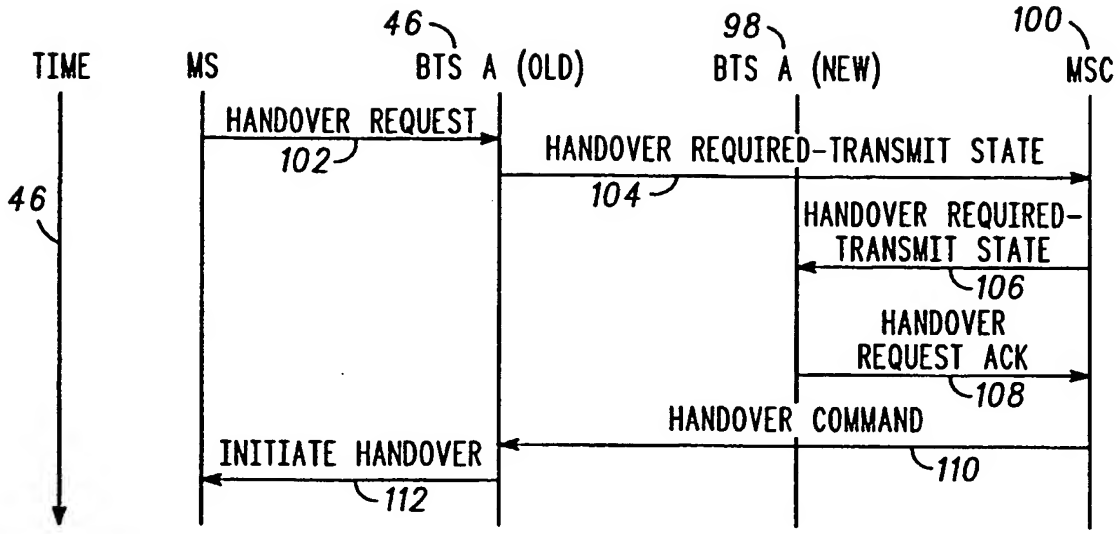

TIME
MS
46
BTS A (OLD)
98
BTS A (NEW)
100
MSC
HANDOVER REQUEST
102
HANDOVER REQUIRED-TRANSMIT STATE
104
HANDOVER REQUIRED-TRANSMIT STATE
106
HANDOVER REQUEST ACK
108
HANDOVER COMMAND
110
INITIATE HANDOVER
112
46

FIG. 9

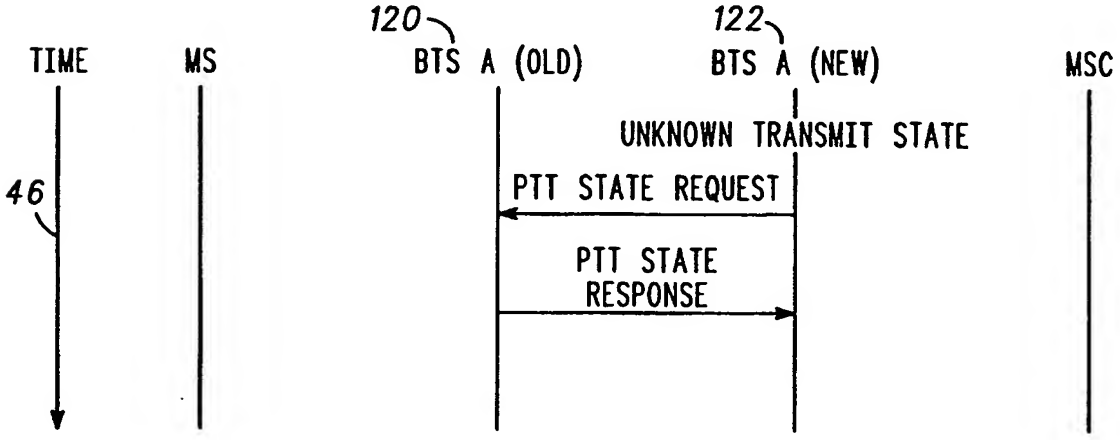

TIME
MS
120
BTS A (OLD)
122
BTS A (NEW)
MSC
UNKNOWN TRANSMIT STATE
PTT STATE REQUEST
PTT STATE RESPONSE
46

FIG. 10

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
10 January 2002 (10.01.2002)

PCT

(10) International Publication Number
WO 02/03581 A3

(51) International Patent Classification[7]: H04Q 7/28, 7/30

(21) International Application Number: PCT/EP01/07624

(22) International Filing Date: 3 July 2001 (03.07.2001)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
0016420.2 5 July 2000 (05.07.2000) GB

(71) Applicant *(for all designated States except US)*: MOTOROLA INC [US/US]; 1303 East Algonquin Road, Schaumburg, IL 60196 (US).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: AITKENHEAD, Gary [GB/GB]; 34 Strawberry Fields, Bramley, Hampshire RG26 25QF (GB). URS, Kamala, Diane [US/US]; 861 Tallgrass Drive, Bartlett, IL 60103 (US).

(74) Agent: MCCORMACK, Derek; Motorola European Intellectual, Property Operations, Midpoint, Alencon Link, Basingstoke, Hampshire RG21 7PL (GB).

(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

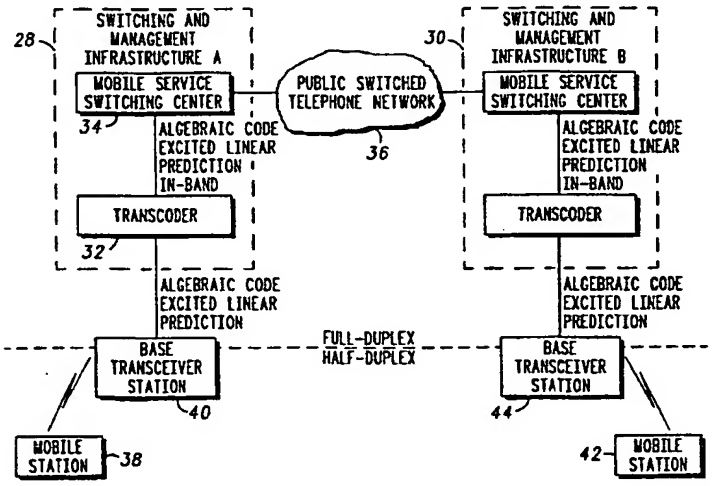
(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report*

(88) Date of publication of the international search report:
4 April 2002

[Continued on next page]

(54) Title: METHOD FOR SUPPORTING HALF DUPLEX CALLS IN A RADIO COMMUNICATIONS SYSTEM



(57) Abstract: A method of communication for supporting half-duplex communications via a full-duplex link, the method comprising the steps of: sending a communication in half duplex format from a first mobile radio communications station MS (38) to a first base transceiver station BTS (40); converting the format of the communication in half duplex format received at the first BTS into a full duplex format and sending the communication converted into the full duplex format from said first BTS (40) to a second BTS (44); converting the format of the communication received at the second BTS back into a half duplex format at the second BTS and sending the communication in the half duplex format to a second MS (42); thereby delivering the communication from said first MS (38) to said second MS (42).

WO 02/03581 A3

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

INTERNATIONAL SEARCH REPORT

International Application No
PCT/EP 01/07624

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H04Q7/28 H04Q7/30

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H04Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5 497 396 A (DELPRAT MARC) 5 March 1996 (1996-03-05) column 3, line 41 -column 5, line 27	1-25
A	US 5 506 837 A (EIZENHOEFER ALFONS ET AL) 9 April 1996 (1996-04-09) the whole document	1-25
A	WO 94 28687 A (YARWOOD ANTHONY CHARLES ;BRITISH TELECOMM (GB)) 8 December 1994 (1994-12-08) page 6, line 5 -page 14, line 21	1-25
A	US 6 021 326 A (NGUYEN HUNG L) 1 February 2000 (2000-02-01) the whole document	1-25

-/--

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
17 December 2001	27/12/2001

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Roberti, V

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

International Application No
PCT/EP 01/07624

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
A	WO 99 12342 A (QUALCOMM INC) 11 March 1999 (1999-03-11) page 6, line 25 -page 16, line 19	1-25
A	GB 2 330 484 A (MOTOROLA AS) 21 April 1999 (1999-04-21) the whole document	1-25

INTERNATIONAL SEARCH REPORT

Information on patent family members

Int ..tional Application No
PCT/EP 01/07624

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
US 5497396	A	05-03-1996	FR	2700087 A1	01-07-1994
			AT	186616 T	15-11-1999
			AU	669940 B2	27-06-1996
			AU	5214493 A	14-07-1994
			CA	2112514 A1	01-07-1994
			DE	69326997 D1	16-12-1999
			DE	69326997 T2	15-06-2000
			DK	605311 T3	15-05-2000
			EP	0605311 A1	06-07-1994
			ES	2139641 T3	16-02-2000
			FI	935884 A	01-07-1994
			JP	6319167 A	15-11-1994
			NO	934858 A	01-07-1994
US 5506837	A	09-04-1996	DE	4304095 A1	18-08-1994
			EP	0611006 A1	17-08-1994
			JP	6350519 A	22-12-1994
WO 9428687	A	08-12-1994	AT	195624 T	15-09-2000
			AU	678247 B2	22-05-1997
			AU	6729494 A	20-12-1994
			CA	2162730 A1	08-12-1994
			CN	1126016 A ,B	03-07-1996
			DE	69425569 D1	21-09-2000
			DE	69425569 T2	26-04-2001
			DK	699371 T3	08-01-2001
			EP	0699371 A1	06-03-1996
			ES	2150990 T3	16-12-2000
			FI	955579 A	20-11-1995
			WO	9428687 A1	08-12-1994
			HU	73703 A2	30-09-1996
			JP	8511920 T	10-12-1996
			NO	954682 A	19-01-1996
			NZ	266204 A	29-01-1997
			SG	47619 A1	17-04-1998
			US	6161016 A	12-12-2000
			PL	311695 A1	04-03-1996
US 6021326	A	01-02-2000	NONE		
WO 9912342	A	11-03-1999	US	6115142 A	05-09-2000
			AU	8689198 A	22-03-1999
			CN	1291402 T	11-04-2001
			EP	1010317 A1	21-06-2000
			JP	2001515316 T	18-09-2001
			WO	9912342 A1	11-03-1999
			US	6281988 B1	28-08-2001
			US	2001040702 A1	15-11-2001
GB 2330484	A	21-04-1999	NONE		